Example 2-3 page 45:

A step-index fiber has a normalized frequency V = 26.6 at a 1300-nm wavelength. If the core radius is 25 μ m, let us find the numerical aperture.

$$V = \frac{2\pi}{\lambda} a\,N.A. \quad \Rightarrow \quad N.A = \frac{\lambda \times V}{a \times 2 \times \pi}$$

$$N.A = \frac{1300 \times 10^{-9}\,m \times 26.6}{25 \times 10^{-6}\,m \times 2 \times 3.14} = 0.2203$$

Questions from the textbook: From Chapter 2 page 78, 79 & 80

2.6 Light traveling in air strikes a glass plate at an angle $\Theta_1 = 33^{\circ}$, where Θ_1 is measured between the incoming ray and the glass surface. Upon striking the glass, part of the beam is reflected and part is refracted. If the refracted and the reflected beams make an angle of 90° with each other, what is the refractive index of the glass? What is the critical angle for this glass?

2.9 Calculate the numerical aperture of a step-index fiber having $n_1 = 1.48$ and $n_2 = 1.46$. What is the maximum entrance angle $\Theta_{0,max}$ for this fiber if the outer medium is air with n =1?

2.20 determine the normalized frequency at 0.82 μ m for a step-index fiber having a 25-μ m core radius, n1 = 1.48, and n2= 1.46. How many modes propagate in this fiber at 0.82 μ m? How many modes propagate at a wavelength of 1.3 μ m? ~~What percentage of the optical power flows in the cladding in each case?~~

2.29 Calculate the number of modes at 820 ηm and 1.3 μ m in a graded-index fiber having a parabolic-index profile ($\alpha = 2$), a 25-μ m core radius, $n_1 = 1.48$, and $n_2 = 1.46$. How does this compare to a step-index fiber?

2.21 Find the core radius necessary for single-mode operation at 820nm of a step-index fiber with $n_1 = 1.480$ and $n_2 = 1.478$. What is the numerical aperture and maximum acceptance angle of this fiber?

2.22 A manufacturer wishes to make a silica-core, step-index fiber with $V = 75$ and a numerical aperture $NA = 0.30$ to be used at 820 nm. If $n_1 = 1.458$, what should the core size and the cladding index be?

2.30 Calculate the numerical apertures of:

a) a plastic step-index fiber having a core refractive index n1= 1.60 and a cladding index n2=1.49.

b) a step-index fiber having a silica core (n1= 1.458) and a silicone cladding (n2=1.405).

Chapter 3

3.1 A certain fiber has an attenuation of 1.5 dB/ km at 1300 nm. If 0.5 mW of optical power is initially launched into the fiber, what is the power level in microwatts after 8Km?

3.2 An optical signal has lost 55 percent of its power after traversing 3.5 km of fiber. What is the loos in dB/ km of this fiber?

3.3 A continuous 12-km –long optical fiber link has a loss of 1.5 dB/ km:

a) What is the minimum optical power level that must be lunched into the fiber to maintain an optical fiber power level of 0.3 μW at the receiving end?

b) What is the required input power if the fiber has a loss of 2.5 dB /km?

Extra questions

1. A fiber of 100-m length has $P_{in} = 10\ \mu$ W and $P_{out} = 9\ \mu$ W. Find the loss in dB/km.

2. A communication system uses 10 km of fiber that has a 2.5-dB/km loss characteristic. Find the output power if the input power is 400 mW.

3. A 3-km fiber optic system has an input power of 2 mW and a loss characteristic of 2 dB/km. Determine the output power of the fiber optic system.

4. What is the maximum core diameter for a fiber if it is to operate in single mode at a wavelength of 1550 nm if the N.A. is 0.12?